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TITLE: METHOD AND SYSTEM FOR
SELECTING AN OPERATING
SYSTEM AT USER LOGIN ON A
TARGET DEVICE

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METHOD AND SYSTEM FOR SELECTING AN
OPERATING SYSTEM AT USER LOGIN ON A TARGET DEVICE

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to client computers that are bootable over a network and, in particular, client computers that may be serviced by multiple boot servers. More specifically, the present invention relates to a method for selecting an operating system on a target device that is remotely booted.

DESCRIPTION OF THE RELATED ART

Some current computing devices include support for pre-boot extensions to download an operating system (OS) from a network to which they are attached. Such target computing devices include computer motherboards, network adapters and boot diskettes. These devices rely on extensions to the bootstrap protocol (BOOTP) and to the dynamic host configuration protocol (DHCP). Such extensions are often termed the preboot execution environment (PXE) and require a DHCP/PXE server and a boot image negotiation layer (BINL) server.

BOOTP is a transmission control protocol/Internet protocol (TCP/IP) used by a diskless workstation, network computer (NC) or other target device to obtain its IP address and other network information, such as server address and default gateway. Upon startup, the target device sends out a BOOTP request to the BOOTP server, which returns the required information. The BOOTP request and response use an IP broadcast function, which is able to send messages before a specific IP address for a target device is known.

DHCP is software that automatically assigns an IP address to a target device logging onto a TCP/IP network. DHCP eliminates the need for manually assigning permanent IP addresses.

5 PXE enables a client network computer or other target device that lacks a native operating system to locate and acquire a small network bootstrap program (NBP) from a BINL server. The target device may acquire this NBP from a BINL server through a network attachment. PXE also provides a means for running the NPB on the target device. This allows the target device to continue acquiring additional software from the network that may be required to make the target device capable of performing the more
10 complex and useful tasks assigned to it by an enterprise.

PXE relies on extensions of DHCP as the means by which the target device locates a BINL server from which to acquire an NPB. A facilitating property of DHCP is that the target device does not need the address of any other computer. The target
15 device performs a DHCP broadcast to discover any PXE proxy server that can recognize that the target device is PXE-capable. The DHCP proxy server sends a DHCP offer to the target device. The offer contains the address of the BINL server from which the target device may obtain a NBP. The target device then obtains the NBP and all necessary software from the boot server via a trivial file transfer protocol (TFTP).

20 Current approaches to selecting the operating system to boot on a target device depend on the BINL server, which is delivered by multiple vendors, such as Intel™, IBM™ and Microsoft™. Each platform has different implementations and behaviors. Once the operating system is booted on a target device, a user can login and use the operating system currently available on the target device. However, if a user moves to
25 a different target device on the network, he cannot have the OS he was using follow him to the new target device. There is also no way for the user to indicate which OS he would like to use on a given target device.

It would be desirable therefore to provide a method of selecting an operating system that overcomes the above.

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SUMMARY OF THE INVENTION

One aspect of the present invention provides a method of selecting an operating system at a target device in communication with a server. A network bootstrap program is initiated at the target device and a bootstrap list command is sent from the target device to the server. An operating systems list is received prior to executing an operating system at the target device and a target operating system is selected from the operating systems list.

Instructions for the target operating system may be received. These instructions may be requested from the server. The target operating system may be booted based on these instructions. A default operating system may be included in the operating systems list. After the target operating system is selected, the network bootstrap program may be relocated. The target operating system may be determined from a configuration file of the target device or may be selected by a user of the target device. The operating systems list may include at least one operating system that is available to the user and/or at least one operating system that is available to the target device.

Another aspect of the present invention provides computer program product in a computer usable medium for selecting an operating system at a target device prior to executing an operating system at the target device. The program may include means for initiating network bootstrap program code at the target device, means for receiving a command requesting an operating systems list of at least one operating system, means for sending the operating systems list to the target device and means for receiving a selection of a target operating system from the operating systems list.

The program may also include means for sending the target operating system to the target device. The program may also include means for determining a default operating system. The program may include means for relocating the network bootstrap program code after the target operating system is selected. The program may also include means for determining the target operating system from a configuration file of the target device. The program may include means for receiving selection of the target operating system from a user. The program may also include

means for determining operating systems that are available to the user or that are available to the device.

Another aspect of the present invention provides a network data processing system. The system may include means for initiating a network bootstrap program at a target device, means for sending a command requesting an operating systems list of at least one operating system, means for receiving the operating systems list prior to executing an operating system at the target device and means for selecting a target operating system from the operating systems list at the target device.

The system may also include means for receiving the target operating system at the target device. The system may also include means for executing the target operating system at the target device. The system may also include means for relocating the network bootstrap program after the target operating system is selected. The system may also include means for determining the target operating system from a configuration file of the target device or from input of a user of the target device.

The foregoing, and other, features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims in equivalence thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of one embodiment of a network of data processing systems in accordance with the present invention;

FIG. 2 is a block diagram of one embodiment of a data processing system in accordance with the present invention;

FIG. 3 is a block diagram of another embodiment of a data processing system in accordance with the present invention;

FIG. 4 is a flow diagram of one embodiment of a method of selecting an operating system in accordance with the present invention;

FIG. 5 is a flow diagram of one embodiment of a method of selecting an operating system continuing the embodiment of **FIG. 4**; and

FIG. 6 is a flow diagram of another embodiment of a method of selecting an operating system continuing the embodiment of **FIG. 4**.

DETAILED DESCRIPTION

FIG. 1 is a schematic representation of a network of data processing systems in accordance with the present invention at **100**. Network data processing system **100** may be a network of computers in which the present invention may be implemented. Network data processing system **100** may contain a network. Network **102** may be any suitable medium used to provide communications links between various devices, such as computers, connected to or in communication with each other within network data processing system **100**. For example, network **102** may include connections, such as wire connections, wireless communication links or fiber optic cables.

In the embodiment of **FIG. 1**, a server **104** may be in communication with network **102**. Server **104** may provide data, such as boot files, operating system images and applications to network **102** and/or to other components in communication with network **102** as described below. System **100** may also include another server **105** which may be identical to or different from server **104**. Server **105** may also provide data, such as boot files, operating system images and applications to network **102** and/or to other components in communication with network **102** as described below. System **100** may also include additional servers (not shown).

One or more storage units, such as storage unit **106** may also be in communication with server **104**, **105** and/or network **102**. Storage unit **106** may store data, such as boot files, operating system images and applications that may be processed or conveyed by server **104**. Storage unit **106** may also store data to be made available to or processed by network **102** and/or to other components in communication with network **102** as described below.

In addition, target devices **108**, **110** and **112** are also in communication with network **102**. These target devices may be, for example, personal computers or network computers. Target devices **108**, **110**, **112** may serve as clients to server **104**.

5 Network data processing system **100** may include additional servers, clients and other devices not shown.

As seen in **FIG. 1**, network data processing system **100** may be any suitable system of processing data. For example system **100** may be the Internet. Alternatively, network data processing system **100** may also be any suitable type of network such as,
10 for example, an intranet, a local area network (LAN) or a wide area network (WAN). In one embodiment of the invention, network **102** represents a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. A backbone of high-speed data communication lines between major nodes or host computers allows communication between thousands of commercial, government,
15 educational and other computer systems that route data and messages.

One embodiment of the present invention provides a network environment, which may include a DHCP/PXE proxy server. For example, server **104** may be a DHCP/PXE proxy server. Alternatively, server **105** may be a DHCP/PXE proxy server. System **100** may also include one or more boot servers. For example server **104** or server **105** may
20 serve as a boot server. These boot servers may be collated on servers **104**, **105** with the DHCP/PXE proxy servers. In one embodiment of the invention, one or more target devices, such as devices **108**, **110**, **112**, may include pre-boot extensions that allow the devices to download OS information from a boot server.

FIG. 2 is a block diagram of a data processing system in accordance with the
25 present invention at **200**. In one embodiment of the invention, data processing system **200** may be implemented as one or more of the servers **104**, **105** shown in **FIG. 1**.

Data processing system **200** may be a symmetric multiprocessors (SMP) system including a plurality of processors **202** and **204** connected to system bus **206**. Alternatively, a single processor system may be employed. Memory controller/cache
30 **208** may also be connected to system bus **206**. Memory controller/cache **208** may provide an interface to local memory **209**. I/O bus bridge **210** may also be connected to

system bus **206** and may provide an interface to I/O bus **212**. Memory controller/cache **208** and I/O bus bridge **210** may be integrated as depicted or may be separate components.

Peripheral component interconnect (PCI) bus bridge **214** connected to I/O bus **212** may provide an interface to PCI local bus **216**. One or more modems may be connected to PCI bus **216**. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors. Modem **218** and network **220** may be connected to PCI local bus **216**. This connection may be through add-in boards. In one embodiment of the invention, modem **218** and accompanying connections provide communications links to target devices such as network computers. For example, such target devices may be those described above at **FIG. 1**.

Additional PCI bus bridges **222** and **224** may provide interfaces for additional PCI buses **226** and **228**. Additional modems or network adapters may be supported from PCI buses **226** and **228**. In this manner, data processing system **200** may allow connections to multiple network computers. A memory-mapped graphics adapter **230** and hard disk **232** may also be connected to I/O bus **212** as depicted, either directly or indirectly.

The components depicted in **FIG. 2** may be arranged as shown or in any suitable manner that allows data processing system **200** to function as desired. Additionally, other peripheral devices, such as optical disk drives and the like, may be used in addition to or in place of the components depicted.

One embodiment of data processing system **200** may be an IBM RISC/System 6000 system, a product of International Business Machines Corporation in Armonk, New York, running the Advanced Interactive Executive, or AIX™, operating system.

FIG. 3 is a block diagram of a data processing system in accordance with the present invention at **300**. Data processing system **300** may be, for example, one or more of the target devices **108**, **110**, **112** depicted in **FIG. 1** and described above. In one embodiment of the invention, data processing system **300** may be a stand-alone system configured to be bootable without relying on a network communication interface. Alternatively, data processing system **300** may also comprise one or more network communication interfaces. Data processing system **300** may also be a personal digital

assistant (PDA) device. Data processing system may also take the form of a notebook computer or handheld computer. Alternatively, data processing system **300** may be a kiosk or Web appliance. The processes of the present invention may also be applied to a multiprocessor data processing system.

5 Data processing system **300** may employ a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Accelerated Graphics Port (AGP) and Industry Standard Architecture (ISA) may be used. Processor **302** and main memory **304** may be connected to PCI local bus **306** via PCI bridge **308**. PCI bridge **308** may also include an
10 integrated memory controller and cache memory for processor **302**. Additional connections to PCI local bus **306** may be made through direct component interconnection or through add-in boards. In one embodiment of the invention, local area network (LAN) adapter **310**, SCSI host bus adapter **312**, and expansion bus interface **314** are connected to PCI local bus **306** by direct component connection. In
15 contrast, audio adapter **316**, graphics adapter **318** and audio/video adapter **319** are connected to PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus interface **314** may provide a connection for additional components such as, for example, a keyboard and mouse adapter **320**, a modem **322** and additional memory **324**. A small computer system interface (SCSI) host bus adapter **312** may
20 provide a connection for additional components such as, for example, a hard disk drive **326**, a tape drive **328**, a CD-ROM drive **330** or a DVD **332**. PCI local bus **306** may be any suitable local bus implementation. Typical PCI local bus implementations support three or four PCI expansion slots or add-in connectors.

In one embodiment of the invention, an operating system (OS) may run on
25 processor **302**. This OS may be used to coordinate and provide control of various components within data processing system **300**. The OS may be a commercially available operating system, such as, for example, Linux™, OS/2 Warp 4, or Windows 2000™. An object oriented programming system may be in communication with the OS and may run in conjunction with the OS. For example, the object-oriented programming
30 system may provide calls to the OS from programs or applications executing on data processing system **300**. These programs or applications may be specific to the object-

oriented programming system or may be programs or applications run by other programming systems. In one embodiment of the invention, the object-oriented programming system may be Java™, a trademark of Sun Microsystems, Inc.

5 Instructions for the OS, the object-oriented operating system, and applications or programs may be located on storage devices such as, for example, hard disk drive 326. These operating systems, applications and/or programs may be loaded into main memory 304 for execution by processor 302.

10 The components of system 300 depicted in FIG. 3 may be arranged as shown or in any suitable manner that allows data processing system 300 to function as desired. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used in addition to or in place of the components depicted. For example, one embodiment of data processing system 300 may be configured with ROM and/or flash ROM in order to provide non-volatile memory for storing operating system files and/or user-generated data.

15 FIG. 4 is one embodiment of a method for selecting an operating system in accordance with the present invention at 400. The operating system selected using this method may be an OS on a target device such as devices 108, 110, 112 depicted in FIG. 1 and described above. A user of a target device may login to the device before or after the process shown at 400 is completed.

20 At block 402, the target device may send a DHCP broadcast. For example, the target device may be connected to a network and send the DHCP broadcast to the network and servers, such as BINL servers, in communication with the network.

25 At block 404, the target device may receive DHCP/PXE proxy offers. These proxy offers indicate which other components in communication with the target device are able to process a BINL request.

At block 406, the target device may send a BINL request to a PXE proxy server. In one embodiment of the invention, this PXE proxy server is one of the proxy offers received at block 404.

At block **408**, the target device may receive a BINL reply from the PXE proxy service. In one embodiment of the invention, this reply indicates the IP address of a BINL server.

At block **410**, the target device may send a TFTP request to the BINL server indicated at block **408**. In one embodiment of the invention, the request is for an initial NPB file. At block **412**, the reply may be received from the BINL server. For example, the server may provide an initial NBP file to the target device.

In one embodiment of the invention, the NBP file is a chained bootstrap. This chained bootstrap may be specified once as the default bootstrap. This chained bootstrap may be the first bootstrap loaded on the target device. This chained bootstrap "chains" itself, e.g., interposes itself in front of, the actual OS/bootstrap to be used on the target machine. In one embodiment of the invention, a reference to this chained bootstrap is the only entry in the BINL server. Alternatively, a reference to this chained bootstrap may be the default reply of the BINL server. Thus, the BINL configuration may not change regardless of the OS/bootstrap eventually used on a given target device. The BINL configuration also may not change when a new OS is added into the system.

At block **414**, a configuration file may be located for the target device. The configuration file may be any suitable file that provides useful data regarding the target device, including information on how the target device is currently configured or information about how target device should be configured. The configuration file may be located in any suitable location in system **200, 300**. In one embodiment of the invention, the configuration file is located on server **104, 105**. The configuration file may indicate which OS and associated bootstrap should be downloaded to boot the target device. In one embodiment of the invention, the configuration file may be written into a directory specific to the target device. The directory may be contained on the target device or on the server. The configuration file may contain location information for and name of the target OS/bootstrap. In one embodiment of the invention, the configuration file is managed by a separate system, making it independent of the implementation of BINL servers from different vendors.

FIG. 5 is another embodiment of a method for selecting an operating system in accordance with the present invention at **500**. The operating system selected using this method may be an OS on a target device such as devices **108, 110, 112** depicted in **FIG. 1** and described above. The process shown at **500** may be used once the process of **FIG. 4** has been used, for example, to retrieve a chained bootstrap. A user of a target device may login to the device before or after the process shown at **500** is completed.

At block **516**, once the configuration file of the target device has been accessed (at block **414**), a list of OS/bootstraps available for the target device may be received. The OS choices may be specified, for example, by a boot manager on a BINL server **104, 105**. In one embodiment of the invention, the target device's configuration file may provide information about the OS/bootstraps that may be used with the target device.

At block **518**, the preferred bootstrap for the target device may be selected. This selection may be automatic. Alternatively, a system administrator or other such entity may select the preferred bootstrap. Alternatively, the user may be provided with the list of available OS/bootstraps and may then select the preferred bootstrap. For example, the user may select a preferred bootstrap from a graphic user interface that shows the list of available OS/bootstraps.

At block **520**, the preferred OS/bootstrap may be requested. In one embodiment of the invention, this request takes the form of a TFTP request to the BINL server.

At block **522**, the preferred OS/bootstrap may be received. For example, the OS and its associated bootstrap may be downloaded to the target device.

At block **524**, the chained bootstrap may then relocate itself so that it does not interfere with the preferred OS/bootstrap. In one embodiment, the chained bootstrap relocates itself in the memory of the target device.

At block **526**, the preferred OS/bootstrap may be loaded on the target device.

At block **528**, the preferred OS/bootstrap may be executed on the target device.

FIG. 6 is another embodiment of a method for selecting an operating system in accordance with the present invention at **600**. The operating system selected using this method may be an OS on a target device such as devices **108, 110, 112** depicted in **FIG. 1** and described above. The process shown at **600** may be used once the process of **FIG. 4** has been used, for example, to retrieve a chained bootstrap. A user of a target device may login to the device before the process shown at **600** is completed.

For example, at block **615**, the user may login to the target device. This login may provide user input that may be used to determine which OS/bootstraps may be made available to the target device based on the user input. In one embodiment of the invention, a user profile is accessed. This profile may be stored in any suitable component of a data processing system **200** or network **300** as described above. In one embodiment, this profile includes the OS systems that the user is authorized or able to use. The OS choices may be specified, for example, by a boot manager on a BINL server **104, 105** based on the user. Alternatively, operating systems that are not available to the logged in user may be disabled and therefore not incorporated into the list of OS/bootstraps available for the target device. For example, the profile for user "AJONES" may only allow user Jones use of Windows 2000™ as an operating system even if the target device's configuration file accessed at **414** indicates that Linux™ and OS/2 Warp 4™ are also available to the target device.

At block **616**, a list of OS/bootstraps available for the user may be received. This list may be a list based on a combination of a configuration file for the target device and a user profile for the user as described above. In the above example, the list of OS/bootstraps received would include only Windows 2000™.

At block **618**, the preferred bootstrap for the target device may be selected. This selection may be automatic. Alternatively, a system administrator or other such entity may select the preferred bootstrap. Alternatively, the user may be provided with the list of available OS/bootstraps and may then select the preferred bootstrap. For example, the user may select a preferred bootstrap from a graphic user interface that shows the list of available OS/bootstraps.

At block **620**, the preferred OS/bootstrap may be requested. In one embodiment of the invention, this request takes the form of a TFTP request to the BINL server. At block **622**, the preferred OS/bootstrap may be received. For example, the OS and its associated bootstrap may be downloaded to the target device. At block **624**, the
5 chained bootstrap may then relocate itself so that it does not interfere with the preferred OS/bootstrap. In one embodiment, the chained bootstrap relocates itself in the memory of the target device. At block **626**, the preferred OS/bootstrap may be loaded and executed (block **628**) on the target device.

While the present invention has been described in the context of a fully
10 functioning data processing system, it will be appreciated that the processes described may be distributed in any other suitable context. For example, the processes described may take the form of a computer readable medium of instructions. The present invention applies equally regardless of the type of signal-bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-
15 type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMS, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing
20 system.

It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended
25 to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein.